

## HETEROPTERAN ADVENTITIOUS BITERS (HEMIPTERA): PRIMITIVELY PREDACEOUS?<sup>1</sup>

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**ABSTRACT:** The foods of most heteropterans are either plants or other arthropods. I surveyed records of bugs which have adventitiously bitten humans, and found that 38 of these records are of bugs whose ancestors were herbivorous. One hundred eighty-four records are of bugs which are, or whose ancestors were, predaceous. The relative ratios of biting records to numbers of bugs in these groups is 3.10 for primarily herbivorous bugs, and 8.50 for primarily predaceous ones. The greater propensity of predaceous bugs to bite humans may reflect similarities between these bugs' usual (or ancestral) hosts and the exudations of humans.

**KEY WORDS:** Heteroptera, nuisance biters, adventitious biters, predation, herbivory.

Heteropterans that adventitiously bite humans are bugs that normally feed on other hosts. From time to time such bugs may attack people; to call such nuisance attacks "accidental" suggests the bugs are confused or distracted; whereas, in fact, the attack may be quite deliberate — a search for fluid, minerals, warmth (see Schaefer 2000a). While writing a chapter on such bugs (Schaefer 2000a), it occurred to me that many of these records are of bugs which were, or whose ancestors were, predaceous; and that there seemed to be fewer records of herbivorous and ancestrally herbivorous bugs. Here I document that impression and briefly discuss it.

Ryckman (1979), Ryckman and Bentley (1979), and I (2000a) have compiled many records of bugs adventitiously biting humans (Table 1). Not listed are records of two groups, some of whose members feed on human blood. Triatomine reduviids and cimicids both feed exclusively on vertebrate blood, and some (a minority) feed on humans. Although most triatomines do not feed on humans, records of adventitious feeding by triatomines are not included in Table 1.

In addition, of the many references to cimicid bites, most but not all refer, of course, to the bedbugs [*Cimex lectularius* L. and *C. hemipterus* (F.)]. Yet several of the others refer to other cimicids that normally do not feed on humans (see also reports in Schaefer 2000b). Nevertheless, like triatomines, all cimicids feed on vertebrate blood, and so they too are not included in Table 1.

Also absent from Table 1 are records of sternorrhynchous hemipterans biting humans. There are few such records, and this paucity probably reflects their very small size and the consequent difficulty of their penetrating human skin. Sternorrhynchs' relatives, grouped para- (or poly-) phyletically as "Auchenorrhyncha," are usually larger and at many times bite humans (Table 1; Schaefer 2000a).

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Table 1. Number of reports of adventitious biting by hemipterans. Several reports contain more than one species, and several reports of the same family may contain the same species. Schaefer's (2000a) reports are in addition to these of Ryckman (1979) and Ryckman and Bentley (1979); the last two reports are combined.

| Family of Hemiptera                                   | Ryckman (1979),<br>Ryckman and Bentley (1979) | Schaefer (2000a) |
|-------------------------------------------------------|-----------------------------------------------|------------------|
| Cydnidae                                              | 1                                             | 2                |
| Pentatomidae<br>(excluding Asopinae)                  | —                                             | 2                |
| Pentatomidae: Asopinae                                | —                                             | 2                |
| Coreidae                                              | 1                                             | —                |
| Rhopalidae                                            | 1                                             | —                |
| Pyrrhocoridae                                         | 8                                             | —                |
| Lygaeidae ( <i>sensu lato</i> )                       | 19                                            | 1                |
| Berytidae                                             | —                                             | 1                |
| Enicocephalidae                                       | 2                                             | —                |
| Reduviidae (excluding<br>Triatominae)                 | 74                                            | —                |
| Nabidae                                               | 12                                            | 1                |
| Anthocoridae                                          | 20                                            | 7                |
| Miridae                                               | 16                                            | 10*              |
| Tingidae                                              | —                                             | 5                |
| Dipsocoridae,<br>Cryptostemmatidae,<br>Ceratocombidae | 2                                             | —                |
| Notonectidae                                          | 7                                             | —                |
| Belostomatidae                                        | 7                                             | —                |
| Naucoridae                                            | 2                                             | —                |
| "Auchenorrhyncha"                                     | 21                                            | 1                |

\*plus 27 additional species of Miridae from Wheeler (2001); total = 59.

There are 38 reports of adventitious biting by bugs belonging to primarily herbivorous groups (i.e., groups whose ancestors were also herbivorous: Cydnidae through Berytidae in Table 1) and 184 reports of such biting by primarily predaceous bugs or bugs which, although herbivorous now, are evolved from carnivorous groups (Enicocephalidae through Naucoridae in Table 1). "Auchenorrhyncha" are not included in either tally. The reports of Lygaeidae (*sensu lato*) do not distinguish between those that feed only on plants and those that also prey upon insects (Geocorinae). The same is true of Pyrrhocoridae, some of whose species are at least, in part, predaceous (see Schaefer 1999).

In addition, the records in Table 1 here do not distinguish between those biters which took in actual internal fluids (cell contents, blood, lymph) and those which either imbibed external fluid (sweat) or nothing at all. This could be an important distinction, as is also the temperature at which these attacks occurred. Very often, under experimental conditions, predaceous bugs will not feed below a certain temperature threshold (A. C. Cohen, personal communication).

Any analysis of these numbers must be far more qualitative than quantitative; the reports overlap to some extent (including the same species) and several reports include more than one species. But the difference is large: 38 reports of biting by primitively herbivorous bugs and 184 reports of biting by bugs either predaceous or secondarily herbivorous (see Schaefer 1997).

However, there are many far more primarily predaceous bugs than primarily herbivorous ones. All the latter are members of the heteropteran infraorder Pentatomomorpha, which has altogether about 12,400 described species. The primarily predaceous bugs belong to these heteropteran infraorders: Enicocephalomorpha (130 species), Dipsocoromorpha (210), Nepomorpha (1900), and Cimicomorpha (19,400; 10,000 of these species are Miridae [Schuh 1995], the largest by far of the heteropteran families); the total of these primarily predaceous infraorders is 21,640 (numbers from Schaefer unpublished). The relative ratios relative ratio of reports to numbers of bugs is 3.10 for primarily herbivorous bugs [ $38/12,400 \times 1,000$ ] and 8.50 for predaceous or secondarily herbivorous bugs [ $184/21,640 \times 1,000$ ]. Because the ratios are very small, I multiply each by 1,000.

Thus, even taking into account the larger number of primarily predaceous bugs, there are proportionately more reports of them feeding adventitiously than of primarily herbivorous bugs doing so; and the relative ratio rises when Miridae are excluded (see Appendix). In addition, the only secondarily predaceous group among the herbivores (Asopinae) has only two records of adventitious biting (see Schaefer 2000a). Note that the ratio for predaceous bugs would greatly increase if the records of adventitious biting by those cimicids and triatomine reduviids that do not normally attack humans were included in the total.

Miridae are herbivorous; many, many are predaceous; and many are both. The family itself is almost certainly descended from predaceous ancestors and its herbivorous members are therefore secondarily herbivorous (see discussion in Wheeler 2001 and Schaefer 1997). Doubtless many of its predaceous members

are descended from herbivores, whereas the feeding habits of others (e.g., Iso-metopinae) are directly descended from that of the predaceous ancestor. Because the family is so large and so diverse, I discuss it separately in an Appendix, while including its species more generally in the discussion here.

These data suggest that ancestral feeding habits (herbivorous and predaceous) are better predictors of adventitious biting than present feeding habits (see Table 2). The reasons for this difference are obscure. Perhaps humans and the usual arthropod prey of predaceous bugs (and formerly predaceous bugs) emit attractants more similar than do plants; and predators (and former predators) are then attracted to such things as volatile amino acids, CO<sub>2</sub>, some degree of warmth, and/or something else given off by both the usual (or former) arthropod prey and humans. Perhaps predators are more attracted to the directed movement of animals, whether prey or not, than they are to the less directed movement of plants. It may simply be that predaceous insects are more ready to use their beaks in defense than are herbivorous insects, and that, therefore, at least some of the records in Table 1 reflect defensive, not feeding, bites. This may be especially true of the three water bugs.

However, the circumstances surrounding the various recorded instances suggest that the bugs were seeking *something*, moisture possibly, more probably salts or organic compounds. Many of the adventitious bitings occurred under warm and humid conditions when the attacked human was sweating; but whether the sweat was the attraction or whether biting occurred because some threshold temperature had been reached remains unknown. For further discussion see Wheeler (2001).

We lack the opposing data to help test these statements: we do not know how often predaceous (and formerly predaceous) herbivores are attracted to nonhost plants. We *do* not know how often bugs which feed on humans are attracted to nonhuman animals or to plants. We *do* know that predaceous bugs will suck juices from plants and that herbivorous bugs will sometimes attack other arthropods. But we lack data similar to, and therefore comparable with, those in Table 1.

Nevertheless, experiments with CO<sub>2</sub>, different human hosts, various volatiles, temperature gradients, etc. should help clarify how significant the differences among these heteropteran groups are.

Table 2. Ancestrally and/or presently predaceous and herbivorous adventitious heteropterans (by family group), with number of reports of adventitious biting in parentheses.

| Feeding Habits          | Presently Predaceous                   | Presently Herbivorous                    |
|-------------------------|----------------------------------------|------------------------------------------|
| Ancestrally Predaceous  | Enicocephalidae (3)                    | Miridae (53)<br>(see Appendix)           |
|                         | Reduviidae<br>(excl. Triatominae) (74) | Tingidae (5)                             |
|                         | Nabidae (13)                           |                                          |
|                         | Anthocoridae (27)                      |                                          |
|                         | Dipsocoridae (2)*                      |                                          |
|                         | Cryptostemmatidae (2)*                 |                                          |
|                         | Ceratocombidae (2)*                    |                                          |
|                         | Notonectidae (7)                       |                                          |
|                         | Belostomatidae (7)                     |                                          |
|                         | Naucoridae (2)                         |                                          |
| Ancestrally Herbivorous | Asopinae (2)                           | Cydnidae (3)                             |
|                         |                                        | Pentatomidae<br>(excluding Asopinae) (2) |
|                         |                                        | Coreidae (1)                             |
|                         |                                        | Rhopalidae (1)                           |
|                         |                                        | Pyrrhocoridae (8)                        |
|                         |                                        | Lygaeidae (s.l.)<br>(most) (20)          |
|                         |                                        | Berytidae (1)<br>"Auchenorrhyncha" (22)  |

\*taken together

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## APPENDIX

The Miridae are abundant and varied enough to be discussed separately. Wheeler, in his fine book on the family, lists the mirids known to have bitten humans (Wheeler 2001, Table 15.1). If one removes from this list those species given by Ryckman (1979) and Ryckman and Bentley (1979), and by me (Schaefer 2000a), 27 species remain. These bring the total of adventitiously biting mirid species to 53, and the total of adventitiously biting primarily predaceous species to 184. Of these 53 mirid species, the basic feeding preferences of 43 can be classified: 13 are mostly or entirely predaceous; 21 are mostly or entirely herbivorous; and 9 are mixed (feed both ways) (information from Wheeler's book). I list the Miridae as "presently herbivorous" in Table 2.

Miridae themselves bite adventitiously less often than other primarily predaceous bugs. The relative ratio for all nonmirid, primarily predaceous bugs (11,640 species, of which there are 131 adventitious-biting records), is 11.25. Thus, inclusion of Miridae among primarily predaceous adventitious biters brings the ratio of such biters down, from 11.25 to 8.4. The ratio for Miridae alone ([53/10,000] x 1,000) is 5.3.

The relative ratios for herbivorous mirids (21 species) and predaceous mirids (13 species) are 2.1 and 1.3, respectively (for mixed species [9]: 0.9). The relative ratio for those 43 species, whose feeding preferences are known, is 4.3. However, these ratios are artificially low, because in calculating them I divided by the total number of mirids (10,000), not by the total number (unknown) of herbivorous, predaceous, and mixed mirids, respectively.

Why mirids bite adventitiously less often than other primarily predaceous bugs, I do not know. Maybe the fact that so many members of this very large family are tropical, and less likely to be reported, is a factor.